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In re Application of: Michael BUCK

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For: IN-TANK FUEL LEVEL DATA NETWORKS FOR RETAILER DATA

INFORMATION DISCLOSURE STATEMENT

MS Patent Application
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Pursuant to the Duty of Disclosure set forth in 37 CFR 1.56, the references listed on the enclosed form PTO-1449 are hereby brought to the attention of the Examiner. A copy of each is enclosed.

The enclosed references are submitted as belonging to the background of the invention. The claimed invention is believed patentable over the enclosed references. The examiner is requested to make an independent judgment.

Respectfully submitted,

Date: 6-23-03

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U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
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	AC						
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						

FOREIGN PATENT DOCUMENTS

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	AL							
	AM							
	AN							
	AO							
	AP							

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THE ENGINEERING HANDBOOK

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University of California, Davis

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128

Computer Communication Networks[1]

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University of Mississippi

The last several years have indeed been exciting times in the brief history of computer communication networks. Over this period of time we have seen the explosive growth of the Internet, a worldwide interconnection of computer communication networks that allows low-latency person-to-person communications on a global basis. So-called **firewall** technology has been developed to the point where more private companies are able to connect to the internet with significantly reduced fear of compromising their important private information. Significant steps have been taken to extend networking services to the mobile information user.

The potential for using networking technology as a vehicle for delivering multimedia—voice, data, image, and video—presentations, and, indeed, multiparty, multimedia conferencing service, is being demonstrated, and the important problems that must be solved in order to realize this potential are rapidly being defined and focused upon. And, perhaps more importantly, user-friendly applications that facilitate navigation within the **World Wide Web** have been developed and made available to networking users on a nonfee basis via network servers, thus facilitating virtually instantaneous search and retrieval of information on a global basis.

By definition, a **computer communication network** is a collection of applications hosted on separate machines and interconnected by an infrastructure that provides communications among the communicating entities. Although the applications are generally understood to be computer programs, the generic model includes the human being as an application.

This chapter summarizes the major characteristics of computer communication networks. Its objective is to provide a concise introduction that will allow the reader to gain an understanding of the key distinguishing characteristics of the major classes of networks that exist today and some of the issues involved in the introduction of emerging technologies.

There are a significant number of well-recognized books in this area. Among these are the excellent texts by Schwartz [1987] and Spragins [1991], which have enjoyed wide acceptance both by students and practicing engineers and cover most of the general aspects of computer

[1]Adapted from Daigle, J. N. 1993. *The Electrical Engineering Handbook*, ed. R. C. Dorf, pp. 1447–1460. CRC Press, Boca Raton, FL.

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communication networks. Other books that have been found especially useful by many practitioners are those by Rose [1990] and Black [1991].

The latest developments are, of course, covered in the current literature, conference proceedings, and the notes of standards meetings. A pedagogically oriented magazine that specializes in computer communications networks is *IEEE Network*, but *IEEE Communications* and *IEEE Computer* often contain interesting articles in this area. *ACM Communications Review*, in addition to presenting pedagogically oriented articles, often presents very useful summaries of the latest standards activities. Major conferences that specialize in computer communications include the IEEE INFOCOM and ACM SIGCOMM series, which are held annually. It is becoming common at this time to have more and more discussion about personal communication systems, and the mobility issues involved in communication networks are often discussed in *IEEE Network* and a new magazine, *IEEE Personal Communication Systems*.

We begin our discussion with a brief statement of how computer networking came about and a capsule description of the networks that resulted from the early efforts. Networks of this generic class, called **wide-area networks** (WANs) are broadly deployed today, and there are still a large number of unanswered questions with respect to their design. The issues involved in the design of those networks are basic to the design of most networks, whether wide area or otherwise. In the process of introducing these early systems, we describe and contrast three basic types of communication switching: circuit, message, and packet.

We next turn to a discussion of computer communication **architecture**, which describes the structure of communication-oriented processing software within a communication-processing system. Our discussion is limited to the **International Standards Organization/Open Systems Interconnection (ISO/OSI) reference model** (ISORM) because it provides a framework for discussion of some of the modern developments in communications in general and communication networking in particular. This discussion is necessarily simplified in the extreme, thorough coverage requiring on the order of several hundred pages, but we hope our brief description will enable the reader to appreciate some of the issues.

Having introduced the basic architectural structure of communication networks, we next turn to a discussion of an important variation on this architectural scheme: the **local-area network** (LAN). Discussion of this topic is important because it helps to illustrate what the reference model is and what it is not. In particular, the architecture of LANs illustrates how the ISO/OSI reference model can be adapted for specialized purposes. Specifically, early network architectures anticipate networks in which individual node pairs are interconnected via a single link, and connections through the network are formed by concatenating node-to-node connections.

LAN architectures, on the other hand, anticipate all nodes being interconnected in some fashion over the same communication link (or medium). This, then, introduces the concept of adaption layers in a natural way. It also illustrates that, if the services provided by an architectural layer are carefully defined, the services can be used to implement virtually any service desired by the user, possibly at the price of some inefficiency.

We conclude with a brief discussion of the status of two recent developments in communication networking: frame relay and asynchronous transfer mode (ATM) technology, which is a part of the larger **broadband integrated services digital network** (BISDN) effort. These technologies are likely to be important building blocks for the computer communication networks of the future.

128.1 General Networking Concepts

Data communication networks have existed since about 1950. The early networks existed primarily for the purpose of connecting users of a large computer to the computer itself, with additional capability to provide communications between computers of the same variety and having the same

operating software. The lessons learned during the first 20 or so years of operation of these types of networks have been valuable in preparing the way for modern networks. For the purposes of our current discussion, however, we think of communication networks as being networks whose purpose is to interconnect a set of applications that are implemented on hosts manufactured by possibly different vendors and managed by a variety of operating systems. Networking capability is provided by software systems that implement standardized interfaces specifically designed for the exchange of information among heterogeneous computers.

The earliest effort to develop large-scale, general purpose networking capability based on packet switching was led by the Advanced Research Projects Agency (ARPA) of the Department of the Army in the late 1960s; this effort resulted in the computer communication network called the ARPANET. The end results of the ARPA networking effort, its derivatives, and the early initiatives of many companies such as AT&T, DATAPOINT, DEC, IBM, and NCR have been far reaching in the extreme. We will concentrate on the most visible product of these efforts, which is a collection of programs that allows applications running in different computers to intercommunicate. Before turning to our discussion of the software, however, we shall provide a brief description of a generic computer communication network.

Figure 128.1 shows a diagram of a generic computer communication network. The most visible components of the network are the *terminals*, the **access lines**, the **trunks**, and the **switching nodes**. Work is accomplished when the users of the network, the terminals, exchange messages over the network.

The terminals represent the set of communication-terminating equipment communicating over the network. Equipment in this class includes, but is not limited to, user terminals, general purpose computers, and database systems. This equipment, either through software or through human interaction, provides the functions required for information exchange between pairs of application programs or between application programs and people. The functions include, but are not limited to, call setup, session management, and message transmission control. Examples of applications include electronic mail transfer, terminal-to-computer connection for time sharing or other purposes, and terminal-to-database connections.

Access lines provide for data transmission between the terminals and the network switching nodes. These connections may be set up on a permanent basis or they may be switched connections, and there are numerous transmission schemes and protocols available to manage these connections.

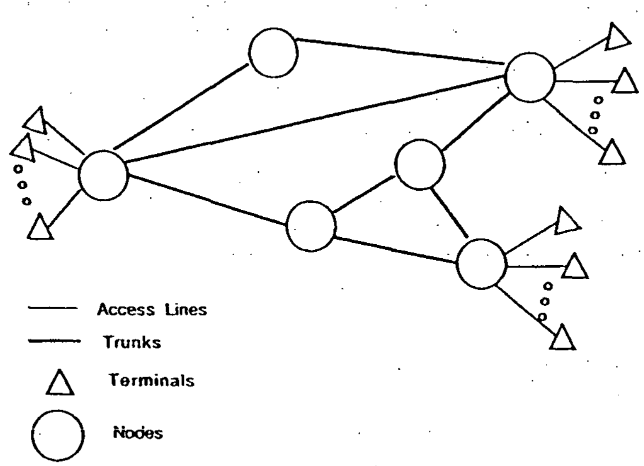

Figure 128.1 Generic computer communication network.

The essence of these connections, however, from our point of view, is a channel that provides data transmission at some number of bits per second (bps), called the *channel capacity, C*. The access line capacities may range from a few hundred bps to in excess of millions of bps, and they are usually not the same for all terminating equipments of a given network. The actual information-carrying capacity of the link depends upon the protocols employed to effect the transfer; the interested reader is referred to Bertsekas and Gallagher [1987], especially chapter 2, for a general discussion of the issues involved in transmission of data over communication links.

Trunks, or internodal trunks, are the transmission facilities that provide for transmission of data between pairs of communication switches. These are analogous to access lines and, from our point of view, they simply provide a communication path at come capacity, specified in bps.

There are three basic switching paradigms: circuit, message, and packet switching. **Circuit switching** and **packet switching** are transmission technologies while **message switching** is a service technology. In circuit switching a call connection between two terminating equipments corresponds to the allocation of a prescribed set of physical facilities that provide a transmission path of a certain bandwidth or transmission capacity. These facilities are dedicated to the users for the duration of the call. The primary performance issues, other than those related to quality of transmission, are related to whether or not a transmission path is available at call setup time and how calls are handled if facilities are not available.

Message switching is similar in concept to the postal system. When a user wants to send a message to one or more recipients, the user forms the message and addresses it. The message-switching system reads the address and forwards the complete message to the next switch in the path. The message moves asynchronously through the network on a message switch–to–message switch basis until it reaches its destination. Message-switching systems offer services such as mailboxes, multiple-destination delivery, automatic verification of message delivery, and bulletin boards. Communication links between the message switches may be established using circuit or packet-switching networks, as is the case with most other networking applications. Examples of message-switching protocols that have been used to build message-switching systems are Simple Mail Transfer Protocol (SMTP) and the International Telegraph and Telephone Consultive Committee (CCITT) X.400 series. The former is much more widely deployed, whereas the latter has significantly broader capabilities, but its deployment is plagued by having two incompatible versions (1984 and 1988) and other problems. Many commercial vendors offer message-switching services based either on one of the above protocols or a proprietary protocol.

In the circuit-switching case, there is a one-to-one correspondence between the number of trunks between nodes and the number of simultaneous calls that can be carried. That is, a trunk is a facility between two switches that can service exactly one call, and it does not matter how this transmission facility is derived. Major design issues include the specification of the number of trunks between node pairs and the routing strategy used to determine the path through a network in order to achieve a given call-blocking probability. When blocked calls are queued, the number of calls that may be queued is also a design question.

A packet-switched communication system exchanges messages between users by transmitting sequences of packets comprising the messages. That is, the sending terminal equipment partitions a message into a sequence of packets, the packets are transmitted across the network, and the receiving terminal equipment reassembles the packets into messages. The transmission facility interconnecting a given node pair is viewed as a single trunk, and the transmission capacity of this trunk is shared among all users whose packets traverse both nodes. Whereas the trunk capacity is specified in bps, the packet-handling capacity of a node pair depends on both the trunk capacity and the nodal processing power.

In many packet-switched networks the path traversed by a packet through the network is established during a call setup procedure, and the network is referred to as a *virtual circuit packet-switching network*. Other networks provide datagram service, a service that allows users to

transmit individually addressed packets without the need for call setup. Datagram networks have the advantage of not having to establish connections before communications take place, but have the disadvantage that every packet must contain complete addressing information. Virtual circuit networks have the advantage that addressing information is not required in each packet, but have the disadvantage that a call setup must take place before communications can occur. Datagram is an example of **connectionless service**, whereas virtual circuit is an example of **connection-oriented service.**

Prior to the late 1970s signaling for circuit establishment was in-band. That is, in order to set up a call through the network, the call setup information was sent sequentially from switch to switch using the actual circuit that would eventually become the circuit used to connect the end users. In an extreme case this process amounted to trying to find a path through a maze, sometimes having to retrace steps before finally emerging at the destination or simply giving up when no path could be found. This system had two negative characteristics: First, the rate of signaling information transfer was limited to the circuit speed, and, second, the circuits that could have been used for accomplishing the end objective were being consumed simply to find a path between the end points. These limitations resulted in tremendous bottlenecks on major holidays, which were solved by virtually disallowing alternate routes through the toll switching network.

An alternate out-of-band signaling system, usually called **common channel interoffice signaling** (CCIS), was developed primarily to solve this problem. Signaling now takes place over a signaling network that is partitioned from the network that carries the user traffic. This principle is incorporated into the concept of integrated services digital networks (ISDNs), which is described thoroughly in Helgert [1991]. The basic idea of ISDN is to offer to the user some number of 64 kbps access lines, plus a 16 kbps access line through which the user can describe to an ISDN how the user wishes to use each of the 64 kbps circuits at any given time. The channels formed by concatenating the access lines with the network interswitch trunks having the requested characteristics are established using an out-of-band signaling system, the most modern of which is Signaling System #7 (SS#7).

In either virtual circuit or *datagram networks*, packets from a large number of users may simultaneously need transmission services between nodes. Packets arrive at a given node at random times. The switching node determines the next node in the transmission path and then places the packet in a queue for transmission over a trunk facility to the next node. Packet arrival processes tend to be bursty—that is, the number of packet arrivals over fixed-length intervals of time has a large variance. Because of the burstiness of the arrival process, packets may experience significant delays at the trunks. Queues may also build due to the difference in transmission capacities of the various trunks and access lines, and delays result. Processing is also a source of delay; the essence of packet-switching technology is to trade delay for efficiency in resource utilization.

Protocol design efforts, which seek to improve network efficiencies and application performance, are frequent topics of discussion at both general conferences in communications and those specialized to networking. The reader is encouraged to consult the proceedings of the conferences mentioned earlier for a better appreciation of the range of issues and the diversity of the proposed solutions to the issues.

128.2 Computer Communication Network Architecture

In this section we begin with a brief, high-level definition of the ISORM, which is discussed in significant detail in Black [1991]. There is significant debate over whether the efforts of the ISO/OSI community are leading to the best standards, but we choose to base our discussion on the ISORM because it is very useful for discussing network architecture principles, and these principles apply across the board.